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(54) **Aircraft landing gear**

Flugzeugfahrwerk

Train d'atterrissage d'avion

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Description

Background

[0001] An aircraft landing gear generally includes a shock absorber arranged to perform spring and damper functions. The shock absorber may contain hydraulic fluid, such as oil. An example of such a shock absorber is the "oleo-pneumatic" type, which combines oil and gas within a vessel to perform spring and damper functions.

[0002] For a fluid-containing shock absorber, the quantity of fluid present in the vessel is important in terms of ensuring the appropriate performance thereof. However, leakage and inappropriate servicing can lead to an inappropriate quantity of fluid in the vessel.

[0003] The present inventor has identified that a need exists for a means by which the appropriateness of the fluid level within such a shock absorber or other vessel can be determined in a manner which is one or more of: quick; simple; reliable; cheap to employ; and a low burden in terms of adding additional weight and/or complexity to the shock absorber.

Summary

[0004] In accordance with a first aspect of the present invention, there is provided an aircraft landing gear according to claim 1.

[0005] Thus, the invention according to this aspect provides a gauge which can be used in maintenance situations to determine whether the oil level within a shock absorber requires modification. The fluid level in the shock absorber is determined to identify a point within the first region. This is generally achieved by locating a boundary between first and second fluids within the vessel i.e. a fluid interface such as an oil/gas interface. Knowing the temperature of the fluid and the extension state of the shock absorber, the user can visually compare the measured point within the first region with the optimum value given by the respective trace to determine whether the fluid level requires modification. Thus, a user may rapidly select the correct course of action substantially without the exercise of particular expertise, calculation or reference to other data sources.

[0006] The third region may comprise a plurality of traces, each trace corresponding to a different temperature value.

[0007] The range of possible oil levels may be a range of possible oil levels during in-use, on-ground, conditions of an aircraft.

[0008] The substrate may comprise a hard material, such as hard plastics or a metal, for example aluminium.

[0009] The first region may be arranged to define a y-axis. The second region may be arranged to define an x-axis. The third region may be arranged to define a graph between the x-axis and y-axis.

[0010] The first region may comprise a space adjacent an edge of the substrate.

[0011] The first region comprises a side face of the substrate or a slot in the substrate. The slot is sized to accommodate a measurement portion of an ultrasonic transducer.

[0012] The range of possible oil levels may comprise a range of possible oil levels during in-use, on-ground conditions.

[0013] In accordance with a further aspect of the present invention, there is provided an aircraft including an aircraft landing gear according to the first aspect.

[0014] In accordance with a further aspect of the present invention, there is provided a method according to claim 10.

[0015] The step of identifying a first point within a first region may comprise moving an ultrasonic sensor within the first region to identify the first point corresponding to the fluid interface. The step of measuring the temperature of a fluid or solid which is relatable to the fluid may comprise using the ultrasonic sensor to measure the temperature of the first fluid.

[0016] The vessel may be an oleo-pneumatic shock absorber. The first fluid may comprise oil. The second fluid may comprise a gas, such as nitrogen.

25 Brief Description of the Drawings

[0017] By way of example only, certain embodiments of the invention will now be described by reference to the accompanying drawings, in which:

Figure 1a is a diagram an aircraft landing gear including a conventional oleo-pneumatic shock absorber in an extended state;

Figure 1b is a diagram of the aircraft landing gear of Figure 1a with the oleo-pneumatic shock absorber in a compressed state;

Figure 2 is a diagram of an aircraft landing gear according to an embodiment of the present invention, including the oleo-pneumatic shock absorber of Figure 1a in combination with a gauge according to an embodiment of the present invention; and

Figure 3 is a diagram of the gauge of Figure 2.

Detailed Description

[0018] Referring to Figure 1a, a diagram of a conventional aircraft landing gear 100 is shown. For clarity, not all parts of the landing gear 100 are shown.

[0019] The landing gear 100 includes a conventional oleo-pneumatic shock absorber 101. A person skilled in the art will be familiar with such a shock absorber 101 and as such, for brevity, its function will only be described briefly. The shock absorber 101 has a casing 102 and a rod 104 slidably mounted therein. A wheel assembly 110 is coupled to a lower region of the rod 104. The shock absorber 101 defines a vessel (not shown) which varies in volume in accordance with the level of extension of the shock absorber 101. The vessel includes oil and ni-

trogen gas. The oil level within the shock absorber 101 is defined by a fluid interface 106, this being a generally planar interface between the oil and gas within the vessel. This interface 106 can be detected in a number of ways, some of which are described in more detail below.

[0020] When the shock absorber 101 is in a relatively extended condition, as shown in Figure 1a, the oil level 106 is at a relatively low level. Referring additionally to Figure 1b, when the shock absorber 101 is in a relatively compressed condition, as shown in Figure 1b, the oil level 106 is at a relatively high level, due to compression of the gas within the vessel. Thus, a range of possible oil levels 108 is defined.

[0021] Figure 2 shows an aircraft landing gear 11 according to an embodiment of the present invention. For clarity, not all parts of the landing gear 11 are shown.

[0022] Like the known landing gear 100, the landing gear 11 of the illustrated embodiment includes a conventional oleo-pneumatic shock absorber 101. However, the shock absorber 101 is in combination with a gauge 10 according to an embodiment of the present invention.

[0023] Referring additionally to Figure 3, the gauge 10 comprises a generally rectangular plate 12 made from aluminium or any other suitable hard material, such as metal or hard plastics. The gauge 10 may be attached to the shock absorber 101 by any suitable means, such as bonding with adhesive or by way of a suitable mechanical fixing.

[0024] A slot 14 formed through a major face of the plate 12. The slot 14 extends along and parallel to an edge of the plate 12 and defines a first region arranged to encompass the range of possible oil levels 108 within the oleo-pneumatic shock absorber 101. By "encompass", it is meant that a range of possible oil levels cross or in some other way are relatable to the slot 14 such that the oil level may be detected by a sensor located within the slot 14. As such, the slot 14 defines a guide channel within which a sensor, such as an ultrasonic sensor, may be positioned and swept to find the oil level 106 within the shock absorber 101. The slot 14 may be considered as defining a y-axis having a range of possible values to which the oil level 106 may correspond.

[0025] The plate further includes an x-axis 16 which defines a second region corresponding to a range of possible extension states of the oleo-pneumatic shock absorber 101. For example, the number of inches or centimetres between two measurable points on the landing gear, such as the distance between the casing 102 and the wheel assembly 110. In this embodiment, the x-axis is substantially orthogonal with respect to the longitudinal axis of the slot 14. The x-axis 16 and its values may be marked in any visually apparent manner; non-limiting examples are by engraving, painting or the like.

[0026] The area between the slot 14 and x-axis 16 defines a third region comprising, in the illustrated embodiment, three traces 18a, 18b, 18c. Each trace 18a, 18b, 18c corresponds to a temperature value for the oil within the shock absorber 101. For example, trace 18a is for an

oil temperature of 10°C, trace 18b is for an oil temperature of 20°C and trace 18c is for an oil temperature of 30°C. Any suitable number of traces may be provided, keeping in mind the balance between resolution and clarity. Each trace 18a, 18b, 18c provides a graphical representation of an optimum relationship between the range of possible oil level values within the slot 14 and the range of extension states on the x-axis 16 at the respective temperature value associated with the trace 18a, 18b, 18c. The trace 18a, 18b, 18c may be marked in any visually apparent manner; non-limiting examples are by engraving, painting or the like.

[0027] While in the illustrated embodiment the traces represent oil temperature values, in other embodiments the temperature values may be ambient temperature or the temperature of the shock strut. However, oil temperature may provide the highest degree of accuracy and in embodiments where the gauge is arranged for use with an ultrasonic sensor to determine the oil/gas boundary, the time of flight measurement may advantageously be used to determine the temperature of the oil, by knowing both the dilation of the vessel and the speed of sound in oil dependency with temperature.

[0028] In use, with the landing gear 11 supporting an aircraft on the ground (not shown), the oil level 106 of the oleo-pneumatic shock absorber 101 may be determined by running a sensor along the slot 14 to identify a point within the first region which coincides with the general plane of the oil level 106. Knowing the temperature of the oil and the extension state of the shock absorber 101, the user can visually compare the measured point in the first region 14 to the optimum value given by the respective trace 18a, 18b, 18c to determine whether the oil level requires modification. For example, a coordinate defined by the measured point within the first region 14 corresponding to the oil level 106 and the measured extension state may be determined within the third region and if the coordinate is on a first side 22 of the respective trace then the user knows that oil should be removed, and if the coordinate is a second side 20 of the respective trace then the user knows that oil should be added. Thus, a user may rapidly select the correct course of action substantially without the exercise of particular expertise, calculation or reference to other data sources. While the gauge has been described for use with a oleo-pneumatic shock absorber, in other embodiments the gauge may be arranged to indicate whether the fluid level in any suitable vessel having a fluid/fluid interface, such as a liquid/gas interface, requires modification. For example, the gauge may be used with reservoirs, hydraulic accumulators and the like. The gauge according to embodiments of the invention may have any suitable first region arranged to encompass a range of possible fluid levels within a fluid-containing shock absorber and enable or permit the fluid level to be determined. For example, rather than including a slot 14, the gauge may be arranged for a sensor to be swept along its side face. In other embodiments the gauge may include a fluid detection strip that

measures the temperature within the shock absorber to find the fluid level. For example, the gauge may include a strip that changes colour dependent on temperature. In such a case, the wall of the shock absorber, or other vessel, should be arranged to permit a reading, such as being thin enough to permit a temperature difference between the oil filled area and gas filled area to be identified if both are heated, or cooled, and then allowed to return to the ambient state; in such a case, the surface adjacent to the gas would cool or heat more rapidly than the surface adjacent to the liquid, allowing an indication by temperature of the gas/liquid interface.

[0029] It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be capable of designing many alternative embodiments without departing from the scope of the invention as defined by the appended claims.

Claims

1. An aircraft landing gear (11) comprising:

an oleo pneumatic shock absorber (101); and **characterised by** a gauge (10) attached to the shock absorber, the gauge (10) being for indicating whether the oil level in the oleo-pneumatic shock absorber (101) requires modification, the gauge comprising:

a substrate (12) for positioning relative to the oleo-pneumatic shock absorber, the substrate comprising:

a first region (14) arranged to encompass a range of possible oil levels within the oleo-pneumatic shock absorber;

a second region (16) corresponding to a range of possible extension states of the oleo-pneumatic shock absorber; and

a third region comprising one or more traces (18a - 18c), each trace corresponding to an oil temperature value and being indicative of an optimum relationship between the range of possible oil levels and the range of possible extension states at the respective temperature value associated with the trace, the gauge being attached to the shock absorber such that the first region of the gauge encompasses a range of possible oil levels for the shock absorber;

wherein the first region comprises a side face of the substrate, or a slot in the substrate by means of which a range of possible oil levels for the shock absorber can be detected by means of a sensor.

2. An aircraft landing gear according to claim 1, wherein the third region comprises a plurality of traces, each trace corresponding to a different temperature value.

3. An aircraft landing gear according to any preceding claim, wherein the range of possible oil levels are a range of possible oil levels during in-use, on-ground, conditions.

4. An aircraft landing gear according to any preceding claim, wherein the substrate comprises a hard material.

5. An aircraft landing gear according to claim 4, wherein the substrate comprises aluminium.

6. An aircraft landing gear according to any preceding claim, wherein the first region is arranged to define a y-axis and the second region is arranged to define an x-axis, the third region is arranged to define a graph between the x-axis and y-axis.

7. An aircraft landing gear according to claim 1, wherein the slot is sized to accommodate a measurement portion of an ultrasonic transducer.

8. An aircraft landing gear according to any preceding claim, wherein the range of possible oil levels are a range of possible oil levels during in-use, on-ground conditions.

9. An aircraft including an aircraft landing gear according to any preceding claim.

10. A method of indicating whether a quantity of oil within an aircraft landing gear oleo pneumatic shock absorber containing the oil and a gas separated by a fluid interface requires modification, the method comprising the steps of:

identify a first point within a first region of a gauge, the first point corresponding to the interface between the oil and gas;

identifying a second point within a second region of the gauge, the second point corresponding to an extension state of the oleo pneumatic shock absorber;

identifying a coordinate in a third region of the gauge, the coordinate being defined by the first and second points, the third region comprising one or more traces, each trace corresponding to a temperature value and being indicative of an optimum relationship between the a range of possible values for the fluid interface and a range of possible values for the extension state at the respective temperature value associated with the trace;

measuring the temperature of a fluid or solid

which is relatable to the oil;
 identifying a trace corresponding most closely
 to the measured temperature; and
 comparing the coordinate with the identified
 trace to indicate whether the quantity of oil re-
 quires modification,
 wherein the first region comprises a side face of
 the substrate, or a slot in the substrate by means
 of which a range of possible oil levels for the
 shock absorber can be detected by means of a
 sensor.

11. A method according to claim 10, whereby:

the step of identifying a first point within a first
 region comprises moving an ultrasonic sensor
 within the first region to identify the first point
 corresponding to the fluid interface; and
 the step of measuring the temperature of a fluid
 or solid which is relatable to the fluid comprises
 using the ultrasonic sensor to measure the tem-
 perature of the oil.

Patentansprüche

1. Flugzeugfahrwerk (11) mit:

einem oleo-pneumatischen Stoßdämpfer (101);
 und
gekennzeichnet durch eine Messvorrichtung
 (10), die an dem Stoßdämpfer befestigt ist, wo-
 bei die Messvorrichtung (10) anzeigt, ob der Öl-
 stand in dem oleo-pneumatischen Stoßdämpfer
 (101) eine Änderung erfordert, wobei die Mess-
 vorrichtung aufweist:
 ein Substrat (12) zur Positionierung relativ zu
 dem oleo-pneumatischen Stoßdämpfer, wobei
 das Substrat aufweist:

einen ersten Bereich (14), der zum Ein-
 schließen eines Wertebereich möglichen
 Ölständen in dem oleo-pneumatischen
 Stoßdämpfer angeordnet ist;
 einem zweiten Bereich (16), der einem Wer-
 tebereich möglicher Erstreckungszustän-
 den des oleo-pneumatischen Stoßdämp-
 fers entspricht; und
 einen dritten Bereich mit einer oder mehre-
 ren Spuren (18a-18c), wobei jede Spur ei-
 nem Öltemperaturwert entspricht und eine
 optimale Beziehung zwischen dem Werte-
 bereich möglicher Ölstände und dem Wer-
 tebereich möglicher Erstreckungszustände
 an dem der Spur zugeordneten jeweiligen
 Temperaturwert anzeigt, wobei die Mess-
 vorrichtung derart an dem Stoßdämpfer be-
 festigt ist, dass der erste Bereich der Mess-

vorrichtung einen Wertebereich möglicher
 Ölstände für den Stoßdämpfer einschließt;
 wobei der erste Bereich einen seitlichen Be-
 reich des Substrats aufweist oder einen
 Spalt in dem Substrat, mittels dessen ein
 Wertebereich möglicher Ölstände für den
 Stoßdämpfer mittels eines Sensors detek-
 tiert werden können.

2. Flugzeugfahrwerk nach Anspruch 1, wobei der dritte Bereich eine Vielzahl von Spuren aufweist, wobei jede Spur einem anderen Temperaturwert entspricht.
3. Flugzeugfahrwerk nach einem der vorstehenden Ansprüche, wobei der Wertebereich möglicher Ölstände ein Wertebereich möglicher Ölstände während Zuständen im Gebrauch und auf dem Boden sind.
4. Flugzeugfahrwerk nach einem der vorstehenden Ansprüche, wobei das Substrat ein Hartmaterial aufweist.
5. Flugzeugfahrwerk nach Anspruch 4, wobei das Substrat Aluminium aufweist.
6. Flugzeugfahrwerk nach einem der vorstehenden Ansprüche, wobei der erste Bereich zum Definieren einer Y-Achse angeordnet ist und der zweite Bereich zum Definieren einer X-Achse angeordnet ist, wobei der dritte Bereich zum Definieren eines Graphen zwischen der X-Achse und der Y-Achse angeordnet ist.
7. Flugzeugfahrwerk nach Anspruch 1, wobei der Spalt derart dimensioniert ist, dass er einen Messabschnitt eines Ultraschallwandlers aufnimmt.
8. Flugzeugfahrwerk nach einem der vorstehenden Ansprüche, wobei der Wertebereich möglicher Ölstände ein Wertebereich möglicher Ölstände während Zuständen im Gebrauch und auf dem Boden sind.
9. Flugzeug mit einem Flugzeugfahrwerk nach einem der vorstehenden Ansprüche.
10. Verfahren zum Anzeigen, ob eine Ölmenge in einem Flugzeugfahrwerk mit oleo-pneumatischem Stoßdämpfer, bei dem das Öl und ein Gas durch eine Fluidschnittstelle getrennt sind, eine Änderung erfordert, wobei das Verfahren folgende Schritte umfasst:
 Identifizieren eines ersten Punkts in einem ersten Bereich der Messvorrichtung, wobei der erste Punkt der Schnittstelle zwischen dem Öl und Gas entspricht;

- Identifizieren eines zweiten Punkts in einem zweiten Bereich der Messvorrichtung, wobei der zweite Punkt einem Erstreckungszustand des oleo-pneumatischen Stoßdämpfers entspricht; 5
Identifizieren einer Koordinate in einem dritten Bereich der Messvorrichtung, wobei die Koordinate durch den ersten und den zweiten Punkt definiert ist, wobei der dritte Bereich eine oder mehrere Spuren aufweist, wobei jede Spur einem Temperaturwert entspricht und eine optimale Beziehung zwischen einem Bereich möglicher Werte für die Fluidschnittstelle und einem Bereich möglicher Werte für den Erstreckungszustand bei dem der Spur zugeordneten jeweiligen Temperaturwert angibt; 10
Messen der Temperatur eines dem Öl zuweisbaren Fluids oder Feststoffs; Identifizieren einer Spur, die der gemessenen Temperatur am ehesten entspricht; und 15
Vergleichen der Koordinate mit der identifizierten Spur, um anzuzeigen, ob die Ölmenge eine Änderung erfordert, wobei der erste Bereich einen seitlichen Bereich Seitenfläche des Substrats aufweist oder einen Spalt in dem Substrat, mittels dessen ein Wertebereich möglicher Ölstände für den Stoßdämpfer mittels eines Sensors detektierbar ist. 25
11. Verfahren nach Anspruch 10, wobei: 30
- der Schritt des Identifizierens eines ersten Punkts in einem ersten Bereich das Bewegen eines Ultraschallsensors in dem ersten Bereich umfasst, um den der Fluidschnittstelle entsprechenden ersten Punkt zu identifizieren; und 35
der Schritt des Messens der Temperatur eines Fluids oder Feststoffs, der dem Fluid zuordenbar ist, die Verwendung des Ultraschallsensors zum Messen der Öltemperatur umfasst. 40
- Revendications**
1. Train d'atterrissage d'aéronef (11) comprenant : 45
- un amortisseur de chocs oléopneumatique (101) ; et
caractérisé par une jauge (10) fixée sur l'amortisseur de chocs, la jauge (10) servant à indiquer si le niveau d'huile dans l'amortisseur de chocs oléopneumatique (101) doit être modifié, la jauge comprenant : 50
un substrat (12) pour le positionnement par rapport à l'amortisseur de chocs oléopneumatique, le substrat comprenant : 55
- une première région (14) agencée pour englober une gamme de niveaux d'huile possibles dans l'amortisseur de chocs oléopneumatique ;
une deuxième région (16) correspondant à une gamme d'états d'extension possibles de l'amortisseur de chocs oléopneumatique ; et
une troisième région comprenant un ou plusieurs tracés (18a-18c), chaque tracé correspondant à une valeur de température d'huile et étant indicatif d'une relation optimale entre la gamme de niveaux d'huile possibles et la gamme d'états d'extension possibles, à la valeur de température respective associée au tracé, la jauge étant fixée sur l'amortisseur de chocs, de sorte que la première région de la jauge englobe une gamme de niveaux d'huile possibles pour l'amortisseur de chocs ;
dans lequel la première région comprend une face latérale du substrat, ou une fente dans le substrat au moyen de laquelle une gamme de niveaux d'huile possibles pour l'amortisseur de chocs peut être détectée au moyen d'un capteur.
2. Train d'atterrissage d'aéronef selon la revendication 1, dans lequel la troisième région comprend une pluralité de tracés, chaque tracé correspondant à une valeur de température différente.
3. Train d'atterrissage d'aéronef selon l'une quelconque des revendications précédentes, dans lequel la gamme de niveaux d'huile possibles est une gamme de niveaux d'huile possibles dans des conditions au sol, en cours d'utilisation.
4. Train d'atterrissage d'aéronef selon l'une quelconque des revendications précédentes, dans lequel le substrat comprend un matériau dur.
5. Train d'atterrissage d'aéronef selon la revendication 4, dans lequel le substrat comprend l'aluminium.
6. Train d'atterrissage d'aéronef selon l'une quelconque des revendications précédentes, dans lequel la première région est agencée pour définir un axe y et la deuxième région est agencée pour définir un axe x, la troisième région est agencée pour définir un graphique entre l'axe x et axe y.
7. Train d'atterrissage d'aéronef selon la revendication 1, dans lequel la fente est dimensionnée pour recevoir une partie de mesure d'un transducteur ultrasonore.
8. Train d'atterrissage d'aéronef selon l'une quelconque des revendications précédentes, dans lequel la

gamme de niveaux d'huile possibles est une gamme de niveaux d'huile possibles dans des conditions au sol, en cours d'utilisation.

9. Aéronef comportant un train d'atterrissage d'aéronef selon l'une quelconque des revendications précédentes. 5

10. Procédé pour indiquer si une quantité d'huile, dans un amortisseur de chocs oléopneumatique de train d'atterrissage d'aéronef contenant l'huile et un gaz, séparés par une interface de fluide, doit être modifiée, le procédé comprenant les étapes suivantes : 10

identifier un premier point dans une première région d'une jauge, le premier point correspondant à l'interface entre l'huile et le gaz ;
 identifier un deuxième point dans une deuxième région de la jauge, le deuxième point correspondant à un état d'extension de l'amortisseur de chocs oléopneumatique ; 15
 identifier une coordonnée dans une troisième région de la jauge, la coordonnée étant définie par les premier et deuxième points, la troisième région comprenant un ou plusieurs tracés, chaque tracé correspondant à une valeur de température et étant indicatif d'une relation optimale entre une gamme de valeurs possibles pour l'interface de fluide et une gamme de valeurs possibles pour l'état d'extension, à la valeur de température respective associée au tracé ; 20
 mesurer la température d'un fluide ou d'un solide qui peut être lié à l'huile ;
 identifier un tracé correspondant le plus étroitement à la température mesurée ; et 25
 comparer la coordonnée avec le tracé identifié pour indiquer si la quantité d'huile doit être modifiée, 30
 dans lequel la première région comprend une face latérale du substrat, ou une fente dans le substrat au moyen de laquelle une gamme de niveaux d'huile possibles pour l'amortisseur de chocs peut être détectée au moyen d'un capteur. 35
 40
 45

11. Procédé selon la revendication 10, selon lequel :

l'étape d'identification d'un premier point dans une première région comprend le déplacement d'un capteur ultrasonore dans la première région pour identifier le premier point correspondant à l'interface de fluide ; et 50
 l'étape de mesure de la température d'un fluide ou d'un solide qui peut être lié au fluide comprend l'utilisation du capteur ultrasonore pour mesurer la température de l'huile. 55

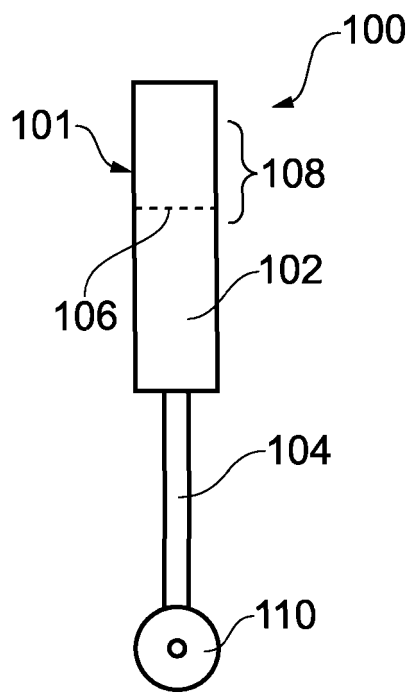


FIG. 1a

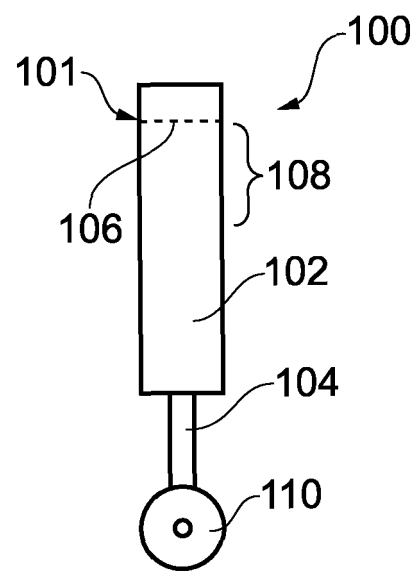


FIG. 1b

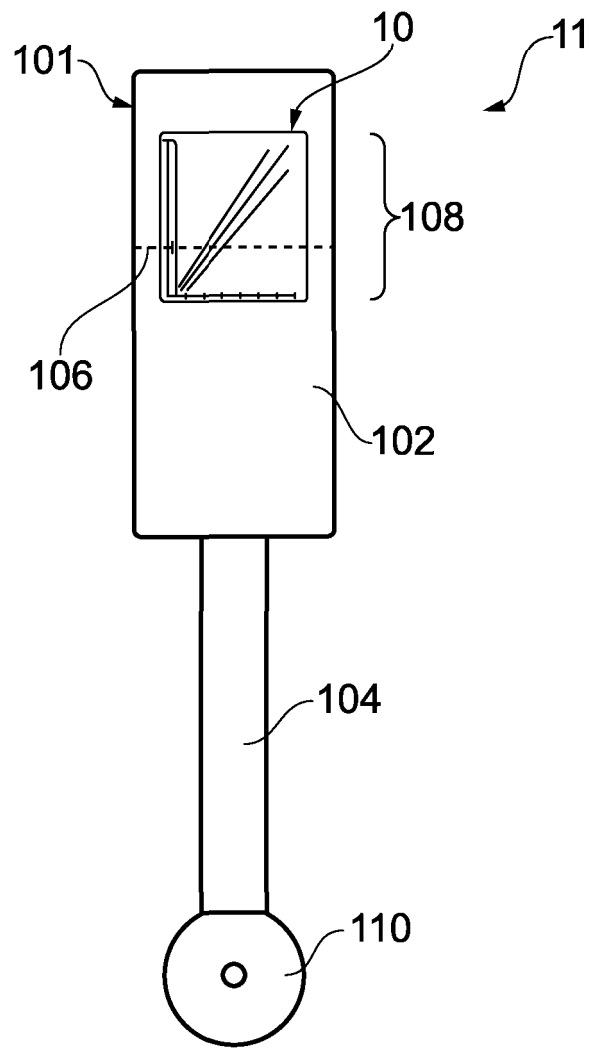


FIG. 2

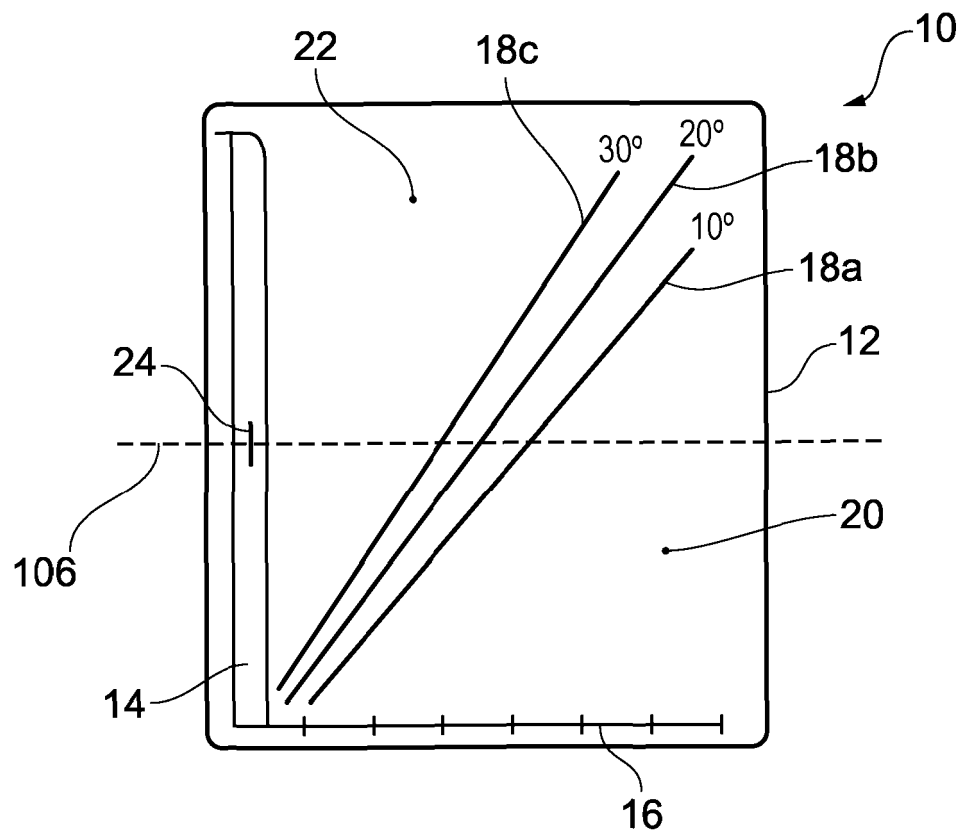


FIG. 3